The Definitive Cost Elements of Subpar Quality in the Navy

The ALRE Flight Safe Program

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"You'll put a plane in the water," says Rich Headley, head of the Navy's Aircraft Launch and Recovery Equipment (ALRE) manufacturing department in Lakehurst, N.J. It's a statement he makes frequently. "Putting a plane in the water" is one of those phrases that gets attention from a lot of folks. Kind of on the same level as screaming "Fire!" in a movie theatre or crying "Wolf!" while on a camping trip. Sometimes you have to put it in language that everyone understands. And around Naval Air Command (NAVAIR), at least today, everyone understands Headley's "Code Blue" call.

What Headley is referring to is the absolute minimum requirement for making parts. But not just any parts. Parts that, when manufactured incorrectly or installed improperly, can fail and have a catastrophic result. Parts that can put a plane in the water, kill people, or destroy airplanes—and cost the Navy millions of dollars. In this arena, Headley sees himself as the "sheriff of quality" with the authority to halt catapult and arresting operations on ships rather than risk Navy resources. (Catapult and arresting equipment encompasses everything necessary to get the aircraft off and then back on ships.) Needless to say, Headley takes his job very seriously.

Flight Safe Program Implemented

Several years ago, during the 2000 timeframe, the quality personnel at NAVAIR Lakehurst began observing an increase in the number of defective parts over the average number of observed defects from prior years. More alarmingly, the defects were in the critical features of the parts rather than minor areas. When critical and major features of parts are non-conforming, it greatly increases the risk that the part will fail during normal operations and directly cause a disastrous event. The NAVAIR engineering department, led by George DiBiase, believed that it was only a matter of time before these material defects translated into catastrophic fleet accidents.

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NAVAIR teamed with the Navy's supply sources and changed the way critical parts are purchased and managed for the ALRE program. Initially, a memorandum of agreement was signed to establish and maintain requisite source approval requirements, quality provisions, and technical data requirements. Following this, another agreement solidified the tracking and certifying of critical components.

The program was named "Flight Safe," building on the popular Navy SUBSAFE program. However the Flight Safe program does not incorporate every feature of the SUBSAFE program. By selectively identifying those features that offer the most economical return for the investment in light of the ALRE-capable fleet and that support infrastructure, the Flight Safe team arrived at an optimum mix.

One of the most common questions put to the Flight Safe team is, "What does it cost?" (Of course, it's the people who don't actually use the ALRE equipment who usually

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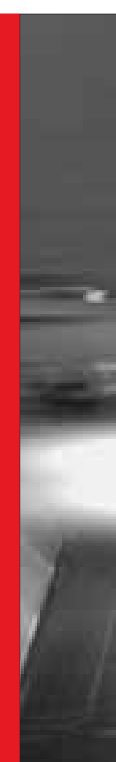


ask. The people who land on aircraft carriers assume all along that the parts are made by quality suppliers and independently inspected before installation.) Headley's response is often aimed at cost avoidance: in other words, if you don't make the part correctly, you'll lose a plane. However, he realizes that there are enormous cost ramifications associated with delivering poor quality products. In this article, we'll identify these cost elements.

What is Quality Anyway?

That question will receive a multiplicity of responses. In the consumer business world, quality is the ingredient that helps to differentiate one product over another. Modern business teaching emphasizes satisfying customers' needs, whether real or perceived, in order to win more customers. Another dimension is that as quality increases, costs will decrease—a direct result of higher sales and of reduced rework, scrap, and warranty claims.

Products with more features or better ingredients are often called "higher-quality" items. Name branded items like Bayer or Coca-Cola® are often perceived to be of better quality than generic products.

Another definition for quality is manufacturing-based, and this is the basis for the Flight Safe program. Manufacturing-based quality implies that the product conforms to the specification documentation.

This article illustrates that the best approach to quality should be a systems approach. When a part is not conforming to the specification—a "poor-quality" item—there likely will be an adverse ripple effect through the supply chain, impacting all stakeholders of the part. Conversely, a "high-quality" part will have a positive effect on the same supply chain.

Recognizing that poor quality transcends more than the bottom line cost, cost estimates are often used as a common denominator to compare one alternative to another. Quality-impacting elements are translated, therefore, to their cost impact. The results demonstrate that total system costs will be at the lowest level when high-quality products are deployed. For the Navy example, cost is inversely correlated to quality.

An Example: The Water Cooled Module and Panel Assembly

Jet blast deflectors (JBDs) are installed directly aft of the catapults on aircraft carrier ships. They function to divert the heat from the jet engines to above the deck, where it is dissipated in the atmosphere. Without this important system, the launching aircraft engine exhaust would pose a hazard to personnel, equipment, and aircraft. When the JBDs are not directing the heat upward, they are lowered into and become an integral part of the flight deck. On the surface area of the JBD facing the jet engine, water-cooled modules are installed. These modules are reinforced, ribbed-based structures that are connected to cooling salt water inlet and outlet piping (Figure 1).

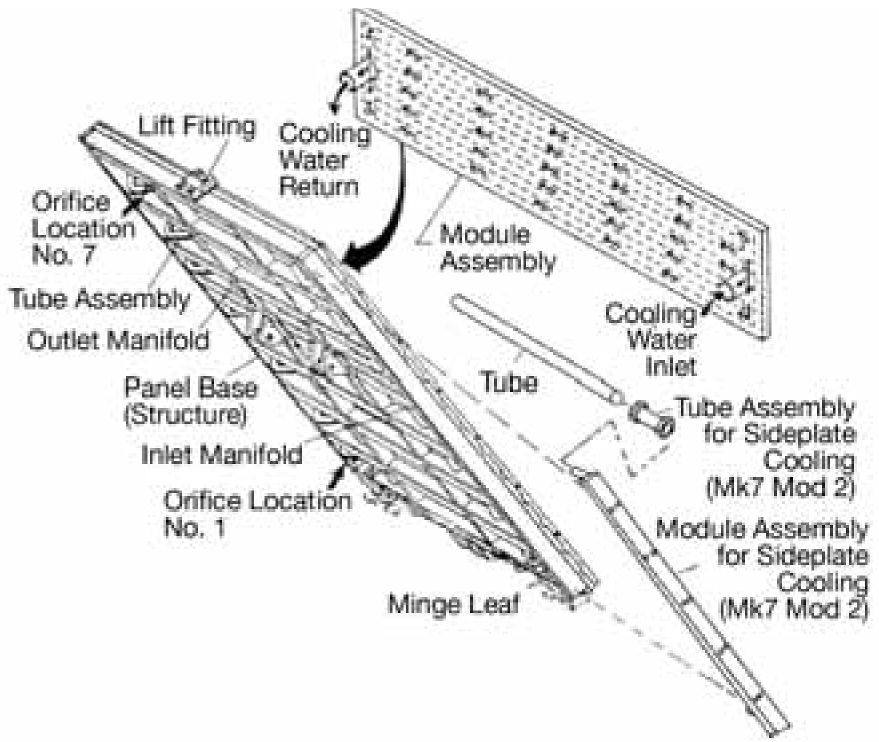
Each water module has hollowed tubes inside that allow for the flow of saltwater from the inlet to outlet ports. Continuously circulated water through the module allows for

With ignited afterburner and loaded with ordnance, an F-14 Tomcat from the "Checkmates" of Fighter Squadron Two One One (VF 211) prepares for launch off the deck of USS John C. Stennis (CVN 74). The JBD is elevated and the 42 modules (Figure 1) are transferring the heat. U.S. Navy photo by Photographer's Mate 3rd Class Troy M. Latham

the transfer of heat from the jet engine to the water and serves to protect the other airplanes on deck as well as the deck personnel from extreme temperature effects. Without the water modules, the heat from the engines would warp and deform the JBD panel and prevent the repeatable cycling of launching aircraft.

Flight operations at sea on Navy aircraft carriers require many tasks to be performed perfectly by many different people. Anyone who has had the opportunity to witness Navy flight operations on a carrier can attest to the almost indefinable number of possibilities for the smallest mistakes to lead to catastrophic accidents. (The fact that Navy personnel accept this high-stress environment as routine and complement their work procedures with a zero accident mentality is worth noting and commending.)

FIGURE 1. **Water-cooled Module and Panel Assembly**



Consider, for example, that anyone on or below deck has the authority to suspend flight operations without clearing it with his or her chain of command. The proper authorities carefully review "foul deck" (a flight deck that is not ready for landings) decisions later, but in the meantime, operations have been halted. And the criteria for stopping at-sea operations are by no means perfectly defined, especially in the aircraft launch and recovery environment.

"What do you mean my catapult is down," the air boss asks the catapult maintenance officer after being summoned to the carrier control tower, O-10 deck. While the conversation remains professional, it is by no means friendly or collegial.

"The JBD modules are spraying salt water all over the aircraft," explains the bos'n. "And several modules show cracked and flaking hard coat surfaces. The F414-GE-400 turbofan engines, the F404-GE-402 enhanced performance turbofan engines on the Hornets, and the Tomcat's F110-GE-400 engines don't do real well with FOD [foreign object damage]. I have to take down the catapult and fix the modules."

After short discussions involving trading-off operations—perhaps moving the jets to a different catapult and moving the "props" to the leaking module catapult—the two reach agreement on a maintenance schedule. First the bos'n estimates manpower and time required to perform the emergency repairs, then the air boss checks schedules to find the optimum time. It is not surprising to get the 3 a.m. to 5 a.m. time slot "again."

The V-2 division on a carrier, the group responsible for maintaining and operating the ALRE equipment, has the task of keeping the equipment in an operational-ready status. As aircraft have increased in speed, weight, complexity, and expense over the past 50 years, the ALRE equipment, by some calculations, has approached its design limitations. In order to maintain safe operations with regard to launching and arresting aircraft, the equipment used by the fleet must, therefore, be manufactured to the exact engineering specifications and maintained accordingly. Typical production variances often permitted in other manufactured parts are frequently grounds for rejection in ALRE.

To perform this ALRE function, the V-2 crew has a busy schedule assuring that all systems are operational. Most of the duties are routine, with little room for unscheduled efforts. So when a piece of equipment breaks, necessitating immediate repair, the assignment is added to an already full work day. Long days become longer. If unscheduled maintenance can be avoided, steps are taken to do so.

Replacement Philosophy

One of the most common unscheduled maintenance avoidance techniques practiced by the ALRE community is to replace an item before it fails. This makes perfect sense. The maintenance cycle is akin to replacing your tires on your car before you have a blowout at high speed. A tire failure while driving will not only require you to replace the tire, it may lead to a chain of events ultimately culminating in loss of control of the vehicle, major damage, and injury or death to the occupants. Replacing worn parts just prior to the failure point allows you to maximize benefit from the installed part and avoid other, unscheduled costs.

If the Navy were to embark on a study of the true total cost of its systems, then quality standards would become evident as cost-saving drivers.

Consumers generally buy tires that are rated for wear by the mileage metric. Under typical driving conditions, consumers expect to get close to the mileage rating for their tires. If you buy tires that are rated for 50,000 miles, you don't expect to replace those tires until your odometer crosses 50,000 miles. This same maintenance ideologue should apply to the Navy. A part should be used to its full design life. As in the civilian world, this would maximize benefit from the part and minimize cost to the program. However, for several reasons, this is not the case.

Our JBD water module is a case in point. While the part is designed to last five years, the Navy replaces it, on average, at a rate 3.8 times higher—the equivalent of buying tires rated at 50,000 miles and replacing them at 14,000 miles. That just doesn't make good economic sense.

In the case of the module, there are underlying reasons why they are replaced more frequently. These reasons, both real and perceived, drive the costs to much higher levels than warranted. When all the costs—acquisition, maintenance, and secondary and tertiary costs—are considered, the Navy is paying a bill that is truly unnecessary. The Flight Safe program is correcting this supply chain anomaly.

Inefficient Cost Drivers

JBD modules are procured by the supply system and kept in storage for normal use and replenishment. The supply system collects usage data from the ships, consolidates the information, and issues timely procurements to replenish stock. During the ALRE audit, several maintenance personnel cited the poor quality of the JBD modules provided by the supply system.

During a three-year period, there were nine product quality deficiency reports (PQDR) issued against one supplier of the modules. (These reports are prepared by users of the equipment and identify problems.) Leaking modules, cracks, poor welds, twisted surfaces (that should be flat), debris left inside, and other dimensional non-conformances were cited. Yet all products had passed the contractor's quality system and were approved for payment by the local government inspectors and administrators. In one case, 98 percent of a single lot of 50 modules from the vendor were rejected for fleet use. Had these not been receipt-inspected per the newly established Flight Safe program prior to delivery to the Navy's storage warehouse, they would have been delivered and installed on ships.

Before deploying, a ship is provided with a coordinated shipboard allowance list (COSAL) that specifies the range and quantities of all equipment considered necessary on an extended deployment for preventative and corrective maintenance actions. What drives these allowances is historical demand. In the relatively finite ALRE community (200 members per ship and an approximate 100 percent turnover rate every four years) formal and informal networks pass on operational stories of the past from one crew to the next. For a JBD module, the COSAL is approximately 60 modules or approximately 40 percent of all in-

FIGURE 2. **Cost Savings Associated with High Quality**

	IDEAL	REALITY	SAVINGS FROM FLIGHT SAFE	% OF COST SAVINGS
ACQUISITION				
Quantity (5 YEAR)	1848	7140	5292	
Cost of Panel to Fleet (CY $2002)	$1,894,200	$7,318,500	$5,424,300	286%
Cost of rel. parts, i.e. fasteners, etc.	$189,420	$731,850	$542,430	
Receipt Inspection	$258,720	$999,600		
FLEET EFFORT				
Total Fleet Time (hours)	37,884	146,370	108,486	
Total Cost per year	$4,652,343	$18,053,000	$13,400,657	288%
Total Cost per year/ship	$930,469	$3,610,600	$2,680,131	
Total Cost per unit	$77,539	$300,883	$223,344	
Total Navy Cost $ (5 YEAR)	$2,518	$2,518		
Quarterly Demand	92	357	265	

stalled modules—a relatively large amount when compared to the design life expectancy of a module, which is five years. Ideally, this COSAL number should be minimized.

During the work-ups of the JBD systems and modules, it is not unusual to find some maintenance issues. Knowing that a defective module at sea will adversely affect the operational capability of the ship (perhaps necessitating midnight maintenance), that the quality history of the part is poor, and that the COSAL inventory may be largely defective, the bos'n may recommend replacing all or many of the modules installed on the ship while the ship is pier-side. After all, better to have all the modules in close-to-perfect, as-new condition, fully checked out *before* deployment to avoid—or at least minimize—unscheduled maintenance at sea.

From an operational standpoint, the approach is ideal. From an economic viewpoint, it's the most expensive. Poor quality drives higher demand; higher demand drives cost. Performance and cost variables need not be mutually exclusive. It is possible, and attainable, to have highest quality parts equate to the lowest total cost. The philosophy of readiness at any cost needs to be replaced with a more economically balanced approach without compromise to safety.

Poor quality, as noted earlier, causes a ripple effect through the supply chain. Higher demand drives the requirement for more contracts for the parts. Higher demand drives more on-hand inventory on deploying ships. The ship has also to carry more ancillary equipment for the modules—for example, tube assemblies, locknuts, couplings, screws, nuts, clamps, and so on that are consumed when modules are replaced.

A substantial cost that often goes unnoticed to almost everyone but the ALRE sailor, is the cost of the labor to replace the modules. Under the ideal, design-life scenario, the ships would expend 37,884 hours over five years replacing modules based on an at-sea environment. In the real world, under the pre-Flight Safe conditions, the number is 146,370 hours. Ideal conditions are rarely achieved, but this difference in hours—108,486—is too great. By achieving the design-life expectancy, the acquisition cost alone on this one part could be reduced by $5,966,730. Equivalent total Navy cost for the same five-year period could be reduced by $13,400,657 (Figure 2).

Additional Costs Result from Poor Quality

There are other costs associated with poor quality that often go overlooked. In the military planning cycle, maintenance expenses often come out of a different budget from acquisition dollars. While there have been several initiatives in the form of guidance and directives for lifecycle costs to be considered during acquisition, the reality is that acquisition costs are usually the basis for awarding contracts.

Navy-Specific Cost Elements

Navy-specific costs associated with maintaining higher inventories include storage space on ships; warehousing; material handling; transportation; documentation processing; rework costs; loss of use of the equipment; engineering and criminal investigations necessary to resolve responsibility for the less than desirable equipment; and additional procurements.

Working long days at sea away from family and living in a high-tempo environment make for a very stressful situation. Issues related to quality of spare parts are, for some personnel, the last straw, as evidenced by the following from a General Accounting Office report to Congress (GAO-01-587): "We recently reported that one of the six factors cited by military personnel as sources of dissatisfaction and reasons to leave the military related to work circumstances such as the lack of parts and materials to successfully complete daily job requirements."

In conclusion, the cost of quality products is definable beyond the catastrophic event. A poor-quality product in the fleet results in the Navy's incurring costs at multiples of the original acquisition cost. Conversely, high-quality parts and assemblies permit reduced cycle times for replacing parts and improve reliability.

Many recognized quality experts have written of the high cost of poor quality. Armand Feigenbaum, one of the early identifiers of the costs associated with quality, talked about the "hidden plant" to describe the part of overall work efforts that consists of searching for mistakes, audits, rework, duplication of efforts, and the performance of unnecessary tasks. W. Edward Deming called it the "buried treasure" in companies and reported these costs, collectively, to be in the range of 25 percent to 40 percent of the cost of manufacturing. However, because of the complex operating environment of the Navy, with ships being deployed far from logistics support centers, the cost to the Navy may be much higher.

Acquisition cost is often not the primary cost driver for Navy total lifecycle cost. Total cost to the Navy is at a minimum when all the parts are defect-free and fully conforming to the engineering specifications. If the Navy were to embark on a study of the true total cost of its systems, then quality standards would become evident as cost-saving drivers. Flight Safe will assure only properly made products reach the fleet.

Editor's note: The author welcomes comments and questions and can be contacted at bucksprofessor@yahoo.com.